WATER RESOURCES REVIEW for JULY 1977

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

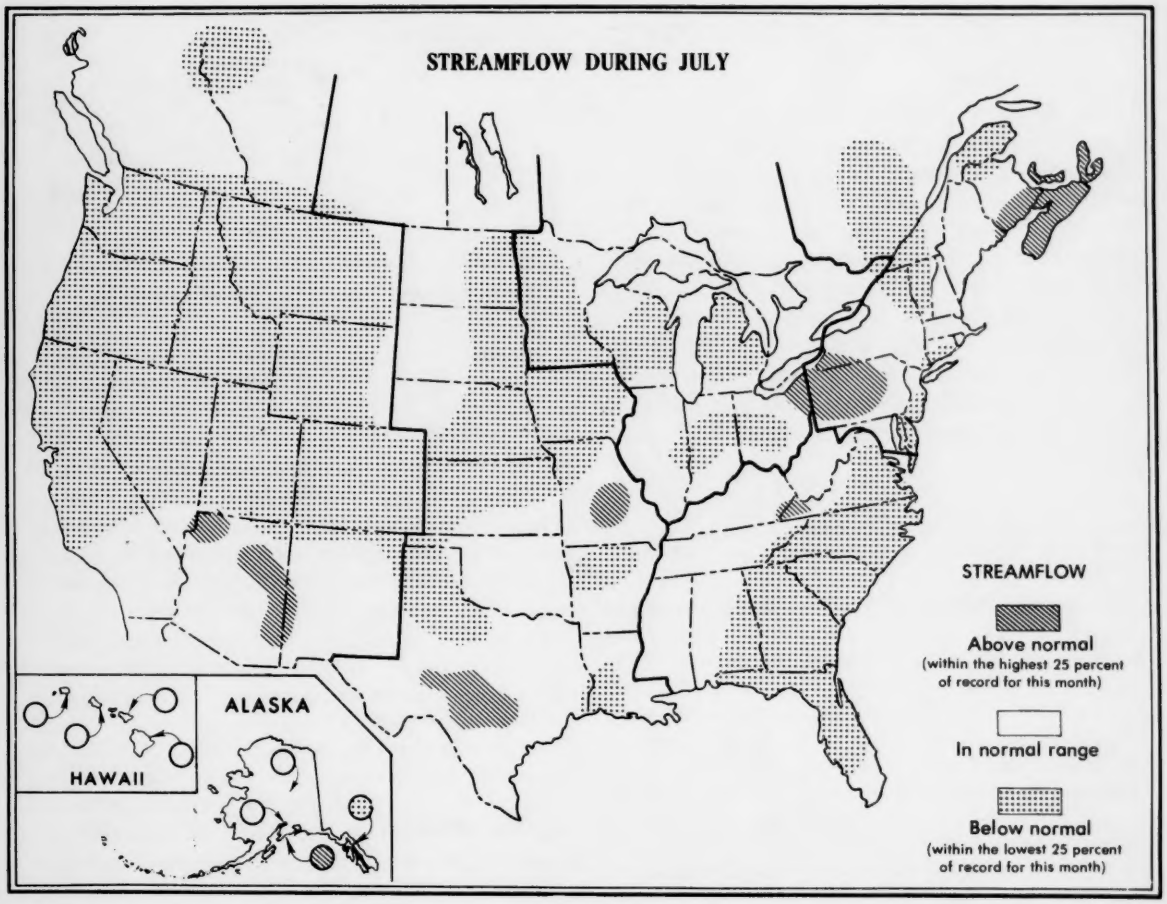
CANADA
DEPARTMENT OF THE ENVIRONMENT
WATER RESOURCES BRANCH

STREAMFLOW AND GROUND-WATER CONDITIONS

Streamflow continued to decrease seasonally except in Arizona and New Mexico, and in parts of Alaska, Hawaii, and some central and southeastern States. Drought conditions and water shortages persisted in many areas and monthly stream flows were below the normal range at 55 percent of the reporting stations in the United States. Flows were lowest of record in parts of California, Colorado, Florida, Idaho, Maryland, Montana, North Carolina, Utah, Virginia, and Quebec, and were highest of record in parts of Alaska and Pennsylvania.

Above-normal flows persisted in parts of the Atlantic Provinces, Texas, and Virginia, and flows increased into the above-normal range in parts of Arizona, Pennsylvania, and Missouri. Flooding occurred in parts of Iowa, Pennsylvania, Missouri, and Utah.

Ground-water levels continued to decline seasonally in the Northeast, Southeast, and in most of the Western States; mixed trends occurred in the Western Great Lakes Region. Levels were in the normal range in the Northeast, and generally below average elsewhere. Locally, however, levels were below average despite slight rises during July, as occurred in Alabama, Arkansas, Minnesota, western Montana, Ohio, Texas and Utah. New monthly highs occurred in Nebraska, Nevada, and Texas. New monthly lows were reached in Iowa, Mississippi, Montana, Nevada, North Dakota, Tennessee, Texas, Utah, and Washington; new alltime lows occurred in Arizona and in the Texas Panhandle.



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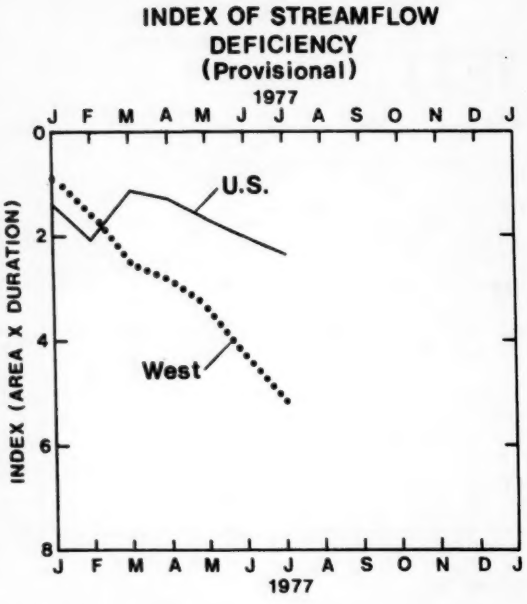


The index of deficient streamflow continued to worsen from a value of 2.0 in June to 2.45 in July, largely due to persistence of the areas of deficient flows, rather than to any increase in area affected. In the West, the index continued its downward course, reaching a value of 5.0 in July. Some encouragement may be gained from the fact that the drought area in the West is not spreading. The southeast is an area to be watched, as the index of deficient streamflow has increased from 0.80 in May to 1.5 in July. [The index represents the arithmetic product, area of deficiency (percent of total area) times the average monthly duration of deficiency.]

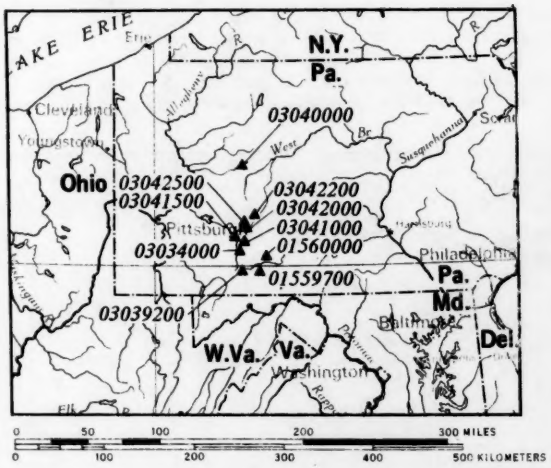
NORTHEAST

[Atlantic Provinces and Quebec; Delaware, Maryland, New Jersey, New York, Pennsylvania, and the New England States]

Streamflow generally decreased seasonally throughout the region but increased in parts of Quebec and Pennsylvania. Monthly mean discharges remained in the above-normal range in parts of the Atlantic Provinces and increased into that range in parts of Pennsylvania. Flows persisted in the below-normal range in parts of Maryland, New Jersey, New York, and Quebec, and decreased into that range in parts of Connecticut and New Brunswick. Flows were lowest of record in southern Quebec and eastern Maryland. Extremely severe flooding occurred in southwestern Pennsylvania.

Ground-water levels declined and were in the normal range in most of the region.

Some of the most devastating flooding in the memory of local residents occurred July 19, 20 in the Susquehanna River, Mahoning Creek, and Kiskiminetas River basins in southwestern Pennsylvania. Rainfall of nearly 12 inches in about 6 hours was reported to have fallen in parts of the flood area and the resulting rapid runoff produced peak stages and discharges on many streams that exceeded any previously known. Selected data on stages, discharges, recurrence intervals, and gaging station locations are given on the accompanying table and map. More than 60 lives were reported lost and preliminary estimates of damage have reached 200 million dollars. The hardest hit area was Johnstown, Pa., where Stony Creek and Little Conemaugh River join to form Conemaugh River.



Location of stream-gaging stations in Pennsylvania, described in table of peak stages and discharges.

In Nova Scotia and southern New Brunswick, monthly mean flows decreased seasonally but remained in the above-normal range as a result of high carryover flows from June and runoff from July rains. In central and southern Nova Scotia, mean discharges in St. Marys River at Stillwater and LaHave River at West Northfield, respectively, were about 3 times median, and in northern Nova Scotia and southern New Brunswick, flows in Northeast Margaree River at Margaree Valley and Lepreau River at Lepreau, respectively, were about twice the July median flows.

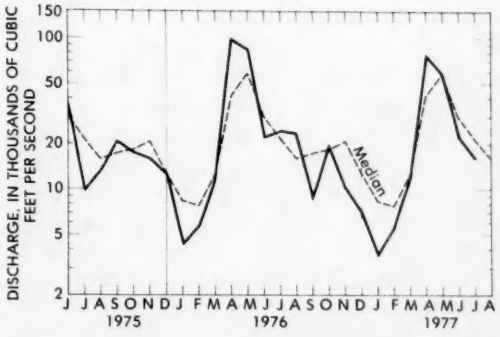
In northwestern Pennsylvania, flow in Oil Creek at Rouseville (drainage area, 300 square miles) increased sharply, from near median in June to 4 times median in July. The daily mean discharge of 3,760 cfs on July 8 was highest for the month since records began at that site in July 1932. In the southern and western parts of the State, where mean flows in Susquehanna River at Harrisburg and Allegheny River at Natrona, respectively, were below the normal range in June, mean discharges increased sharply in July and were in the above-normal range.

FLOOD DATA FOR SELECTED SITES IN PENNSYLVANIA, JULY 1977

WRD station number	Stream and place of determination	Drainage area (square miles)	Period of known floods	Maximum flood previously known			Maximum during present flood				
				Date	Stage (feet)	Discharge (cfs)	Date	Stage (feet)	Discharge		Recurrence interval (years)
									Cfs	Cfs per square mile	
	PENNSYLVANIA										
	SUSQUEHANNA RIVER BASIN										
01559700	Buffalo Run tributary near Manns Choice.	5.28	1961–	Sept. 28, 1967	4.26	1,010	July 20	5.12	2,300	436	300
01560000	Dunning Creek at Belden.	172	1939–	June 23, 1972	12.67	12,000	20	14.15	19,000	110	500
	MAHONING CREEK BASIN										
03034000	Mahoning Creek at Punxsutawney.	158	1938–	June 23, 1972 Mar. 18, 1936	15.94 15.6	17,300 12,500	20	16.20	12,000	76	50
	KISKIMINETAS RIVER BASIN										
03039200	Clear Run near Buckstown.	3.68	1961–	June 23, 1972	4.53	266	20	5.03	350	95	50
03040000	Stony Creek at Ferndale.	451	1913–36, 1938–	Mar. 18, 1936	[a]30.26	59,000	20	22.4	64,000	142	500
03041000	Little Conemaugh River at East Conemaugh.	183	1935,	Mar. 17, 18, 1935	.....	28,800	20	18.97	40,000	219	500
			1939–	June 23, 1972	10.42	16,600					
03041500	Conemaugh River at Seward--9 miles downstream from Johnstown.	715	1936, 1938–	Mar. 18, 1936 Oct. 16, 1954 June 23, 1972	26.4 19.2 18.93	90,000 54,000 49,300	20	27.06	95,000	133	250
03042000	Blacklick Creek at Josephine.	192	1952–	June 23, 1972	13.99	20,800	20	19.89	55,000	286	500
03042200	Little Yellow Creek near Strongstown.	7.36	1960–	June 23, 1972	6.10	820	20	9.31	1,600	217	500
03042500	Two Lick Creek at Graceton.	171	1951–	June 23, 1972	14.69	19,600	20	18.7	45,000	263	500

[a]Site and datum then in use.

In southwestern Quebec, where monthly mean flow in Coulonge River at Fort Coulonge was in the below-normal range during May and June, and where flow normally decreases during July, monthly mean discharge increased contraseasonally, was greater than median and in the normal range. In the south-central part of the Province, mean flow in St. Maurice River at Grand Mere continued to decrease seasonally and remained below the normal range. (See graph.) In southeastern Quebec, south of St. Lawrence River, monthly mean discharge in Saint Francois River at Hemmings Falls decreased sharply from the above-normal flow of June, and was in the below-normal range. In the extreme eastern part of the Province, south of St. Lawrence River, where mean



Monthly mean discharge of St. Maurice River at Grand Mere, Quebec (Drainage area, 16,300 sq mi; 42,200 sq km)

flow in Matane River at Matane was above the normal range for 4 consecutive months, March–June, mean flow during July decreased sharply and was below the normal range.

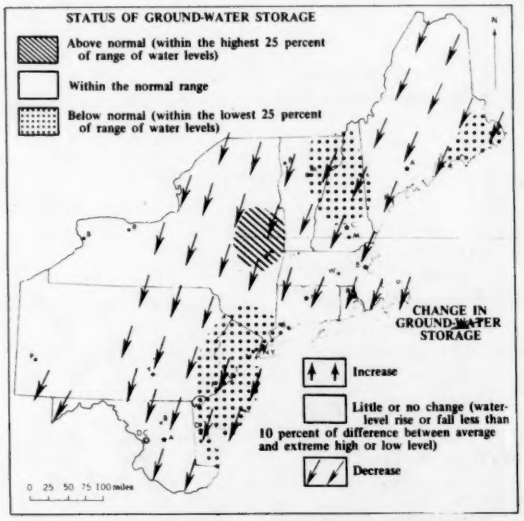
In the New England States, monthly mean flow in White River at West Hartford, Vt. (drainage area, 690 square miles), continued to decrease seasonally and remained below the normal range for the 3d consecutive month. The monthly mean discharge of 185 cfs was appreciably greater than the July monthly mean of 109 cfs, which occurred during the drought of 1965. Also in Vermont, monthly mean flow in Passumpsic River at Passumpsic was equal to the 3d lowest monthly flow for July since records began in 1928. In southern Connecticut, monthly mean flows decreased sharply from the above-median flows of June, were about one-half of July median flows, and were below the normal range. Elsewhere in the New England States, flows decreased seasonally and were in the normal range.

In the Adirondack Mountains of northeastern New York, monthly mean flow of Hudson River at Hadley continued to decrease seasonally and remained below the normal range. Elsewhere in the State, flows decreased seasonally and were in the normal range.

In southern New Jersey, monthly mean flow in Great Egg Harbor River at Folsom (drainage area, 56.3 square miles) also continued to decrease seasonally, was in the below-normal range for the 8th consecutive month, and the mean discharge of 25.7 cfs was only slightly greater than the minimum July monthly mean of 22.1 cfs, recorded during the drought of 1966, in record that began in September 1925.

In the extreme southern part of the region, in eastern Maryland, where monthly mean flow in Choptank River near Greensboro (drainage area, 113 square miles) continued to decrease seasonally, and was below the normal range for the 6th consecutive month, the monthly mean discharge of 9.19 cfs, and the daily mean of 2.3 cfs on the 24th, were lowest for July since records began in January 1948. As a result of the revision of the monthly mean discharge reported for June, monthly means have been lowest of record at this station for 3 consecutive months. Also in the southern part of the region, monthly mean flow in Potomac River near Washington, D.C. (drainage area, 11,560 square miles) continued to decrease seasonally, was about one-half the July median flow, and remained below the normal range for the 3d consecutive month. In records that began at this station in March 1930, both the July monthly mean discharge of 2,470 cfs, and the minimum daily mean of 1,670 cfs on July 10, were appreciably greater than the respective July monthly minimum of 1,190 cfs, and the July daily minimum of 814 cfs, both of which were recorded during the drought of 1966.

Ground-water levels declined seasonally in most of the region. (See map.) The few exceptions included higher



Map shows ground-water storage near end of July and change in ground-water storage from end of June to end of July.

levels in some wells on Long Island, N.Y., and in some parts of western New York, Pennsylvania, and Maryland. Levels near end of month were within the normal range for this time of year in most of the region. The principal exception was a large area centered on New Jersey where levels were generally below average, as they were also in most of New Hampshire. Levels were above average in some wells in western Pennsylvania and extreme western New York and Maryland.

SOUTHEAST

[Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia]

Streamflow decreased seasonally in most States of the region but increased seasonally in parts of Florida, Georgia, and Mississippi. Contraseasonal increases occurred in parts of Alabama, Kentucky, Virginia, and West Virginia. Flows remained in the below-normal range in parts of Alabama, Florida, Georgia, North Carolina, Virginia, and West Virginia, and decreased into that range in South Carolina and eastern Tennessee. Record-low flows occurred in parts of Florida, North Carolina, and Virginia. Monthly mean flows were below normal at one-half of the reporting stations.

Ground-water levels generally declined in the region, and were mostly below average except in Kentucky and Alabama, where they were slightly above average. Record lows occurred in Tennessee and Mississippi.

In northern Florida, the monthly mean discharge of 53 cfs in Ochlockonee River near Havana (drainage area, 1,140 square miles), was only 8 percent of median and lowest for the month since records began in June 1926. Similarly, in the east-central part of the State, the monthly mean flow of 46 cfs in St. John River near Christmas (drainage area, 1,539 square miles), was only 6 percent of median flow for the month and lowest for July since records began in October 1933. In west-central and northwestern parts of the State, mean flows in Peace River at Arcadia, and Shoal River near Crestview, respectively, increased seasonally but remained below the normal range. In northeastern Florida, mean flow in Suwannee River at Branford decreased contraseasonally and was in the below-normal range for the first time since April 1976.

In east-central North Carolina, flow in Neuse River near Clayton (drainage area, 1,140 square miles), continued to decrease seasonally, and the monthly mean discharge of 94.3 cfs, and the daily mean of 68 cfs on the 24th, were lowest for July in record that began in August 1927. In the adjacent basin of Cape Fear River, flow as measured at William O. Huske lock near Tarheel decreased sharply to 30 percent of median, and remained below the normal range for the 3d consecutive month. In west-central North Carolina, mean flow in South Yadkin River near Mocksville continued to decrease, and was in the below-normal range for the 5th time in the past 6 months. In the extreme southwestern corner of the State, monthly mean flow in French Broad River at Asheville decreased sharply into the below-normal range.

In north-central Virginia, flow in Rapidan River near Culpeper (drainage area, 472 square miles), decreased rapidly during the first 10 days of the month, reaching a minimum daily mean discharge of 20 cfs on the 10th, lowest for July in record that began in 1931. A sharp increase in flow occurred on the 11th and the monthly mean discharge was slightly more than that of June but was below the normal range for the 5th time in the past 6 months. In the central part of the State, mean flow in Slate River near Arvonia decreased sharply, to 44 percent of median for July, and was in the below-normal range for the 3d consecutive month. In the extreme southwestern corner of the State, high carryover flow from June, augmented by runoff from rain early in July, held monthly mean flow in the above-normal range, in marked contrast to flows in other parts of the State.

In the Potomac River basin in northern West Virginia and adjacent areas of Maryland and Virginia, flow of Potomac River at Paw Paw, W. Va., continued to decrease seasonally but was in the normal range for July, in contrast to the below-normal flows at that site during May and June. In eastern West Virginia, mean flow in Greenbrier River at Alderson increased contraseasonally, and also was in the normal range, following 2 months of below-normal flow.

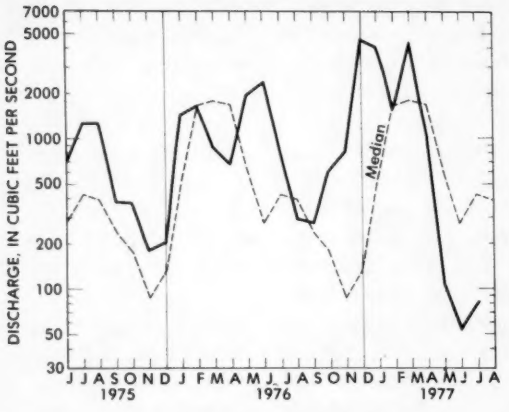
In extreme eastern Tennessee, where monthly mean discharge of French Broad River below Douglas Dam was above the normal range in June, flow decreased sharply into the below-normal range in July. Elsewhere in the State, flows continued to decrease seasonally and remained in the normal range.

In northern Kentucky, where mean flow in Licking River at Catawba was below the normal range and only 14 percent of median in June, monthly mean discharge increased contraseasonally and was within the normal range in July. In the southern part of the State, flow in Green River at Munfordville continued to decrease seasonally and remained in the normal range for the 5th consecutive month.

In western Mississippi, where flow in Big Black River near Bovina was below the normal range and about one-fourth of median in May and June, monthly mean discharge increased sharply in July and was in the normal range. Elsewhere in the State, flows generally increased in the southern part and decreased in the north, but remained within the normal range.

In southeastern Alabama, monthly mean flow in Conecuh River at Brantley decreased contraseasonally, was only one-third of median for July, and was below the normal range for the 3d consecutive month. In contrast, flow in Tombigbee River at Demopolis lock and dam, near Coatopa, in northwestern Alabama, increased contraseasonally, following 2 months of below-normal flow, and was in the normal range. In the central part of the State, mean flow in Cahaba River at Centreville continued to decrease seasonally and remained in the normal range for the 3d consecutive month. In the Shoal River basin, in southeastern Alabama and the adjacent area of northwestern Florida, the monthly mean discharge on the main stem, as measured near Crestview, Fla., increased seasonally but remained below the normal range for the 3d consecutive month.

In the Apalachicola River basin in extreme western Georgia, monthly mean flow, as measured near the Georgia-Florida border at Chattahoochee, Fla., decreased seasonally and was below the normal range for the first time since April 1972. In south-central Georgia, monthly mean flow in Alapaha River at Statenville increased seasonally, but because of low carryover flow from June, remained in the below-normal range and was only 19 percent of median. (See graph on page 6.) In the northeastern part of the State, mean flows in Oconee River near Greensboro and Altamaha River at



Monthly mean discharge of Alapaha River at Statenville, Ga. (Drainage area, 1,400 sq mi; 3,630 sq km)

Doctortown continued to decrease seasonally and remained in the below-normal range for the 3d consecutive month. In extreme northern Georgia, flow in Etowah River at Canton also continued to decrease seasonally, and was below the normal range for the first time since February 1977. Monthly mean flows were above the normal range at this station in March and April, and within the normal range in May and June.

In northeastern South Carolina, where monthly mean flow of Lynches River at Effingham was below the normal range in May, and above the normal range in June, flow decreased sharply in July and again was below normal. In the adjacent basin of Pee Dee River, the monthly mean discharge at Peedee continued to decrease seasonally, was only one-half of the July median flow, and remained below the normal range for the 3d consecutive month.

Ground-water levels in West Virginia rose slightly and were above average in the north-central part of State, but declined and were below average elsewhere. In Kentucky, levels declined seasonally but continued above average in most areas. In Virginia, levels declined and were below average in the three principal observation wells. In western Tennessee, the 10th consecutive new monthly low, for the end of July, was reached in the key well in the "500-foot sand" near Memphis; this also was a new alltime low in 35 years of record. Levels in North Carolina declined Statewide; they continued below average in the eastern Piedmont and Coastal Plain, but continued above average in the western Piedmont and in the mountains. Levels in South Carolina declined seasonally but were about normal for the end of July. In Mississippi, levels declined. Alltime lows were established in numerous wells screened in the heavily pumped Sparta Sand in the Jackson area, and along the Gulf Coast in wells screened in the Pascagoula and Graham Ferry Formations. Levels in wells in the Sparta Sand in the Jackson area ranged from about 4 to 10 feet lower than a year ago, reflecting the above-normal ground-water withdrawals from the Sparta Sand for industrial and irrigation use during the unusually dry spring and summer months. In Alabama, levels in the two key wells declined but remained slightly above average. In Georgia, levels in most wells in the Piedmont ranged from 1 to 2 feet lower than June and from 1 to 4 feet lower than a year ago. In the Savannah area, levels in and near the center of pumping ranged from 5 to 10 feet lower than June and from 7 to 9 feet lower than a year ago. In the outlying areas, levels were about 2 feet lower than June and ranged from 4 to 5 feet lower than a year ago. Levels in Bryan and Liberty Counties were about 1 foot lower than in June and about 3 feet lower than a year ago. In the Brunswick area farther south, levels in wells in and near the center of pumping were about 3 feet lower than June, and from 4 to 7 feet lower than a year ago. In the outlying areas, levels were about 2 feet lower than last month and from 2 to 5 feet lower than a year ago. In Florida, levels declined in most areas of northern Florida during July. Compared with those of last month, levels ranged from less than 1 foot above, near Pensacola and Orlando, to 2.6 feet below, north of Tallahassee. End-of-month levels ranged from 2 feet below to 4.7 feet below the July average. In southeast Florida, levels were generally less than ½ foot lower than last month and ranged from near the July average to about 1.2 feet below it.

WESTERN GREAT LAKES REGION

[Ontario; Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin]

Streamflow continued to decrease seasonally in Minnesota, but was variable in the other States of the region, and in Ontario. Flows remained below the normal range in Minnesota and in parts of Indiana, Michigan, Ohio, and Wisconsin, and increased into the normal range in Illinois and Ontario.

Ground-water levels rose and were above normal in Illinois, rose but were generally below normal in Minnesota and Ohio, and declined and were below normal generally elsewhere in the region, with a new low for July recorded in Michigan.

In Minnesota, monthly mean flows in Minnesota River near Jordan and Mississippi River at St. Paul decreased seasonally, were one-fourth and one-third, respectively, of the July median flows, and were below the normal range for the 14th time in the past 15 months. Similarly, in the central and west-central parts of the State, mean

(Continued on page 8.)

SELECTED DATA FOR THE GREAT LAKES, GREAT SALT LAKE, AND OTHER HYDROLOGIC SITES

GREAT LAKES LEVELS

Water levels are expressed as elevations in feet above International Great Lakes Datum 1955

(Data furnished by National Ocean Survey, NOAA, via U.S. Army Corps of Engineers office in Detroit. To convert data to elevations above mean sea level datum of 1929, add the following values: Superior, 0.96; Michigan-Huron, 1.20; St. Clair, 1.24; Erie, 1.57; Ontario, 1.22.)

Lake	July 31, 1977	Monthly mean, July		July		
		1977	1976	Average 1900–75	Maximum (year)	Minimum (year)
Superior (Marquette, Mich.)	600.56	600.50	601.37	600.90	601.89 (1950)	598.99 (1926)
Michigan and Huron (Harbor Beach, Mich.)	578.55	578.58	580.52	578.71	581.04 (1974)	575.96 (1964)
St. Clair (St. Clair Shores, Mich.)	574.23	574.31	575.74	573.87	576.20 (1973)	571.88 (1934)
Erie (Cleveland, Ohio)	571.53	571.68	572.77	570.95	573.34 (1973)	568.46 (1934)
Ontario (Oswego, N.Y.)	244.98	245.06	246.97	245.49	247.74 (1947)	242.75 (1934)

GREAT SALT LAKE

Alltime high: 4,211.6 (1873). Alltime low: 4,191.35 (October 1963).	July 31, 1977	July 31, 1976	Reference period 1904–76		
			July average, 1904–76	July maximum (year)	July minimum (year)
Elevation in feet above mean sea level:	4,199.75	4,201.25	4,198.5	4,204.4 (1923)	4,192.15 (1963)

LAKE CHAMPLAIN, AT ROUSES POINT, N.Y.

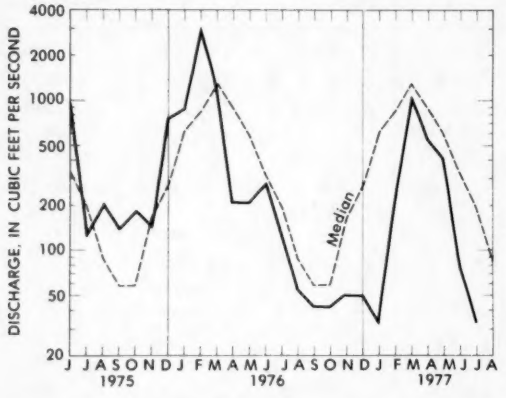
Alltime high (1827–1975): 102.1 (1869). Alltime low (1939–1975): 92.17 (1941).	July 28, 1977	July 31, 1976	Reference period 1939–75		
			July average, 1939–75	July max. daily (year)	July min. daily (year)
Elevation in feet above mean sea level:	94.84	96.99	95.69	99.34 (1973)	93.81 (1965)

FLORIDA

Site	July 1977		June 1977	July 1976
	Discharge in cfs	Percent of normal	Discharge in cfs	Discharge in cfs
Silver Springs near Ocala (northern Florida)	700	92	675	760
Miami Canal at Miami (southeastern Florida)	203	69	461	171
Tamiami Canal outlets, 40-mile bend to Monroe	162	62	12	426

(Continued from page 6.)
flows in Crow River at Rockford and Buffalo River near Dilworth, were one-fourth and one-third, respectively, of median flow for July, and remained in the below-normal range, where they have been in 14 of the past 15 months.

In northeastern Indiana, monthly mean discharge in Mississinewa River at Marion decreased sharply, to 17 percent of median, remained below the normal range, and was only 0.5 cfs greater than the minimum July monthly mean discharge of 32.6 cfs, recorded in 1936. (See graph.) Records began at this site in September



Monthly mean discharge of Mississinewa River at Marion, Ind. (Drainage area, 862 sq mi; 1,766 sq km)

1923. In western Indiana and the adjacent area of eastern Illinois, monthly mean flow of Wabash River, as measured at Mt. Carmel, Illinois, decreased sharply, to 31 percent of median, and remained below the normal range. In the southeastern part of the State, mean flow in East Fork White River at Shoals increased contraseasonally, was 1½ times the July median flow, and in the normal range.

In Michigan's Upper Peninsula, where monthly mean flow in Sturgeon River near Sidnaw was below the normal range in May and June, flow increased contraseasonally, as a result of runoff from thunderstorms on the 17th, and was in the normal range. In the northern part of the Lower Peninsula, where the monthly mean discharge of Muskegon River at Evart was lowest of record in both May and June, flow continued to decrease seasonally, and remained in the below-normal range where it has been in 10 of the past 11 months. In the southern part of the Lower Peninsula, mean flow in Red Cedar River at East Lansing also continued to decrease seasonally and remained below the normal range.

In northern Wisconsin, where monthly mean flow in June in Jump River at Sheldon was below the normal range for the 13th time in the past 14 months, the monthly mean discharge during July was in the normal range. Also in the northern part of the State, where mean flow in June in Chippewa River at Chippewa Falls was below the normal range for the 14th consecutive month, flow increased into the normal range in July as a result of runoff from thunderstorms. In west-central Wisconsin, flow of Wisconsin River at Muscoda decreased seasonally and remained below the normal range for the 14th consecutive month. In the east-central part of the State, monthly flows in Fox River at Rapide Croche Dam, near Wrightstown, also decreased seasonally and was below the normal range for the 13th time in the past 14 months. In northeastern Wisconsin, monthly mean discharge in Oconto River near Gillett continued to decrease seasonally and was in the below-normal range for the 12th time in the past 14 months.

In northwestern Ohio, monthly mean flow in Maumee River at Waterville increased sharply as a result of runoff from rains July 1, 2, and was 1½ times the median flow for the month. In the northeastern part of the State, mean flow in Little Beaver Creek near East Liverpool continued to decrease seasonally, but as a result of increased flow from rains on July 21, monthly mean discharge was above the normal range and about 2½ times median. Flooding occurred in Wooster on July 21. In south-central Ohio, mean flow in Scioto River at Higby increased contraseasonally but remained in the below-normal range.

In southwestern Ontario, monthly mean flow in English River at Umfreville increased contraseasonally and was in the normal range. In south-central and southeastern parts of the Province, mean flows in Missinaibi River at Mattice and Saugeen River near Port Elgin, respectively, decreased seasonally but were in the normal range, following 2 months of below-normal flow at each station.

In the Rock River basin, in northwestern Illinois, where flow in Pecatonica River at Freeport in June was in the below-normal range for the 13th consecutive month, monthly mean discharge increased sharply as a result of runoff from heavy rains near month's end, and was in the normal range. Downstream, on the main stem, Rock River at Joslin also increased contraseasonally and was in the normal range, following 6 consecutive months of below-normal flow.

Ground-water levels in shallow water-table wells in Minnesota rose but remained below average. The level in the key well near Hanska, Brown County, in south-central Minnesota rose nearly 3 feet and, although 4 feet below average, was 4½ feet above the level of a year ago. In Wisconsin, levels generally declined after a slight rise in mid-July in response to substantial rains, and were

below average at the end of the month. In Michigan, levels continued to decline and were below average; a new low for July was reached in the key well in the western part of the Upper Peninsula. In northwestern Illinois, the level in the shallow index well in glacial drift at Princeton, in Bureau County, rose again after its June decline, and was nearly 2 feet above average at the end of July--the first above-average level noted in 6 months. Levels were about the same as those of last month in western Indiana, but below average; wells in the eastern part of the State declined nearly a foot and were well below average at month's end. Levels rose slightly in central Ohio but were below average; those in northeastern Ohio rose and were close to average at the end of the month.

MIDCONTINENT

[Manitoba and Saskatchewan; Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas]

Streamflow continued to decrease seasonally in most of the region, but increased in Arkansas and in parts of Iowa, Louisiana, Missouri, and North Dakota. Monthly mean flows remained in the below-normal range, where they have been for 16 consecutive months in parts of Iowa, 14 of the past 15 months in parts of North Dakota and South Dakota, for 12 of the past 14 months in parts of Missouri, and for shorter periods in parts of Arkansas, Kansas, Louisiana, and Texas. Flooding occurred in parts of Iowa and Missouri.

Ground-water levels declined in most of the region, but levels rose in some of the observation wells in Kansas and Texas. Levels rose in response to decreased pumping in some wells in Arkansas and Louisiana. New monthly highs were reached in Nebraska and Texas, and new monthly lows in North Dakota, Iowa, and Texas; again, a new alltime low was reached in the Texas Panhandle.

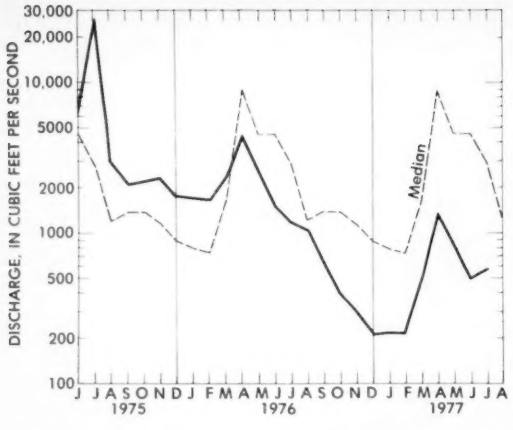
Streamflow conditions improved slightly in the southeastern part of the region. For example, in southern Missouri, where monthly mean flow in Gasconade River at Jerome was below the normal range in 9 of the 11 months through June, flow increased contraseasonally as a result of runoff from heavy rains near the beginning of July, and was above the normal range. Also, in northern Arkansas, where monthly and daily mean flows in Buffalo River near St. Joe during June were lowest of record for the month, flow increased contraseasonally in July and the monthly and daily mean discharges were 3 times the minimum July flows of record. In the southern part of the State, where mean flows in Saline River near Rye were below normal in May and June, monthly mean discharge also increased contraseasonally in July and was in the normal range. Similarly, in northern Louisiana, where monthly mean discharge in Saline Bayou near Lucky was about one-fourth of median and below the normal range during May and June, mean flow increased contraseasonally in July and was in the normal range. By contrast, in the southern part of that State, monthly mean flows continued to decrease seasonally and were below the normal range in Calcasieu River near Oberlin.

In Iowa, flows increased slightly at index stations in eastern and southwestern parts of the State, and minor flooding occurred along small creeks in extreme eastern and northwestern parts. Monthly mean flow in Cedar River at Cedar Rapids, in eastern Iowa, increased contraseasonally but was only 20 percent of median and in the below-normal range for the 13th consecutive month. Similarly, mean flow in Nishnabotna River above Hamburg, in southwestern Iowa, increased contraseasonally, was only 17 percent of median, and below the normal range for the 7th consecutive month. In northwestern Iowa, monthly mean flow in Des Moines River at Fort Dodge (drainage area, 4,190 square miles) decreased seasonally to 122 cfs (62 percent greater than the minimum July daily mean discharge of record, which occurred in 1926), was only 10 percent of median flow for the month, and remained below the normal range for the 16th consecutive month. In the central part of the State, mean flow in Des Moines River below Raccoon River at Des Moines also decreased seasonally, was only 3 percent of the July median flow, and was below the normal range for the 13th consecutive month.

In the Grand River basin of northwestern Missouri and the adjacent area of southwestern Iowa, the monthly mean discharge at the index station near Gallatin, Mo., increased contraseasonally but was only 14 percent of the July median, and was below the normal range for the 9th consecutive month.

In the Red River of the North basin, in eastern North Dakota and the area of western Minnesota, mean flow at Grand Forks, N. Dak., increased contraseasonally but was only 19 percent of median, and was in the below-normal range for the 14th time in the past 15 months. (See graph on page 10.) In the southwestern part of the State, mean flow in Cannonball River at Breien decreased seasonally but remained in the normal range.

In central South Dakota, monthly mean flow in Bad River near Fort Pierre decreased seasonally but remained in the normal range. In the Big Sioux River basin in eastern South Dakota and the adjacent area of Minnesota and Iowa, monthly mean flow at the index station at Akron, Iowa, decreased seasonally, was only



Monthly mean discharge of Red River of the North at Grand Forks, N. Dak. (Drainage area, 30,100 sq mi; 78,000 sq km)

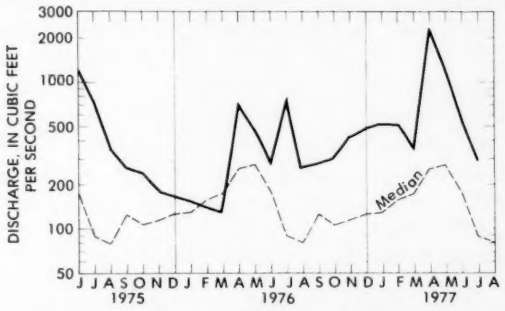
23 percent of median, and was in the below-normal range for the 14th time in the past 15 months.

In northeastern Nebraska, monthly mean flow in Elkhorn River at Waterloo decreased seasonally and was below the normal range for the 11th time in the past 14 months. The mean discharge was 4 times the July minimum monthly mean, which occurred in 1936. In the northwestern part of the State, mean flow in Niobrara River above Box Butte Reservoir also decreased seasonally, but remained in the normal range. Streamflow in southwestern and southeastern parts of Nebraska was much below normal during July, in contrast to flow of streams in the Sand Hills area, in the north-central part of the State, which was above normal for July.

In Kansas, streamflow was below normal in western and central parts of the State, and near normal in the east. For example, the monthly mean discharge of 3.3 cfs in Saline River near Russell (drainage area, 1,502 square miles), in western Kansas, was only 4 percent of the July median flow, was in the below-normal range for the 11th time in the past 14 months, and was only 0.6 cfs greater than the July minimum monthly discharge of record, which occurred during the drought of 1964. In northeastern Kansas, and the adjacent area of southeastern Nebraska, mean flow in Little Blue River near Barnes, Kans., decreased sharply, was only one-half of median, and was below the normal range. In the southwestern part of the State, monthly mean flow in Arkansas River at Arkansas City decreased seasonally but remained within the normal range.

In south-central Oklahoma, mean flow in Washita River near Durwood decreased sharply and was less than median, but remained in the normal range for the 9th consecutive month. Elsewhere in the State, flows also were below the median flows for July.

In south-central Texas, mean flow in Guadalupe River near Spring Branch decreased seasonally but remained in the above-normal range for the 4th consecutive month and continued to be 3 times the median discharge. (See graph.) Above-normal flow occurred also in the San Saba



Monthly mean discharge of Guadalupe River near Spring Branch, Tex. (Drainage area, 1,315 sq mi; 3,406 sq km)

River and upper Guadalupe River basins. In eastern Texas, monthly mean discharge in Neches River near Rockland continued to decrease seasonally and was less than median, but was in the normal range. In the west-central part of the State, monthly mean flow in North Concho River near Carlsbad decreased seasonally and remained within the normal range.

In southeastern Saskatchewan, monthly mean flow in Qu'Appelle River near Lumsden decreased seasonally, was only slightly less than median, and remained within the normal range.

In southern Manitoba, mean flow in Waterhen River below Waterhen Lake also decreased seasonally and remained in the normal range. The level of Lake Winnipeg at Gimli averaged 711.76 feet above mean sea level (same as in June), 2.44 feet lower than the long-term mean, 6.50 feet lower than the maximum level for July (1974), and 1.33 feet above the minimum level for July (1941).

Ground-water levels in North Dakota declined and were more than 3 feet below average in the east and nearly average in the southwest. The level in the water-table well at Wyndmere, in eastern North Dakota, reached a new low for July—the third consecutive monthly low at this well. In Nebraska, levels generally declined throughout the State during the month. In the central, east-central, and southeastern parts of the State, heavy pumping at municipal and irrigation wells caused levels to decline a foot or more; levels were below long-term averages and below the levels of a year ago. In the northern part of the State, especially in the Sand Hills region, levels were still above average and above the levels of last year. The index well at Dunning registered a new high for July, despite a decline of ¾ of a foot. In

Iowa, levels in shallow water-table wells generally declined and continued generally below average. A new low level for July was reached in the shallow well in glacial drift in Linn County in eastern Iowa. Levels in Kansas showed mixed trends but continued generally below average. In the rice-growing area of east-central Arkansas, the water level in the shallow aquifer declined slightly, but was in the same range that has prevailed since 1964. The level in the deep aquifer--the Sparta Sand--continued to decline, reflecting not only the rice-growing season but also the considerable pumping that was necessary for row-crop irrigation in May and June because of a 35-day dry period. In the industrial aquifer of central and southern Arkansas--the Sparta Sand--the level in the key well at Pine Bluff rose about 3 feet, but was 10.3 feet below average and 4.5 feet lower than a year ago. The rise in water level in this area was caused by the closing of local industrial plants--the largest water users--for the Fourth of July weekend. In Louisiana, levels declined in all major aquifers except the Chicot aquifer in the southwest, which recovered because of decreasing pumping for rice irrigation. The level in the key well in the terrace aquifer of central Louisiana declined slightly but continued above average. In Texas, levels rose at Houston with a new high for July, and rose slightly but were below average in the bolson deposits at El Paso where, despite the rise, levels were at a new monthly low. Levels declined but were above average in the Edwards Limestone at Austin and San Antonio, with a new July high at Austin despite the decline of ¾ foot since the end of June. Once again, a new alltime low was reached in the Ogallala Formation at Plainview in the Panhandle.

WEST

[Alberta and British Columbia; Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming]

Streamflow decreased seasonally, except in Arizona and New Mexico, and was lowest of record for July in parts of California, Colorado, Idaho, Montana, and Utah. Drought conditions persisted in much of the region, and monthly mean flows remained below the normal range in parts of each State and Province except Arizona and British Columbia. Flows were above the normal range in parts of Arizona and extreme southwestern Utah, and flash flooding occurred in northeastern Utah. Monthend reservoir contents generally were below normal.

Ground-water levels declined in most of the region except in the two key wells in Montana, in one of the wells in Idaho, and in two of the wells in Arizona; levels were mostly below average. New lows for July were recorded in Washington, Montana, New Mexico, Nevada, and Utah, and a new high in Nevada. Three new alltime lows were reached in Arizona.

In Kings River basin in south-central California, in the Sierra Nevada west slope and tributary to San Joaquin River, the monthly mean discharge of 303 cfs, and the daily mean of 180 cfs on the 31st, at the index station above North Fork, near Trimmer (drainage area, 952 square miles) were lowest for July in 48 years of record. The previous July minimums were 312 cfs (monthly), and 214 cfs (daily), recorded in 1961 and 1934, respectively. Monthly mean flow at this site has been below the normal range for 8 consecutive months, and cumulative runoff for the first 10 months of this water year (October 1976 through September 1977) was only 34 percent of median. In northern California, also in the Sierra Nevada west slope, but tributary to Sacramento River in the northern Central Valley, the daily mean discharge of 15 cfs on the 31st, in North Fork American River at North Fork Dam (drainage area, 342 square miles) was the same as the minimum daily mean for July (in record that began at a site near Colfax in 1911) which was recorded in 1924. The monthly mean flow of 26.1 cfs during July was only 18 percent greater than the minimum monthly mean of record (also recorded in 1924), was below the normal range for the 10th consecutive month, and was only 19 percent of median. Cumulative runoff for the first 10 months of this water year was only 12 percent of median runoff. In the north-coastal basin of Smith River, mean flow at the index station near Crescent City continued to decrease seasonally, was below the normal range for the 9th time in the past 10 months, and cumulative runoff during that 10-month period was only 23 percent of median. Similarly, on the east slope of the central Sierra Nevada, monthly mean flow of West Walker River below Little Walker River, near Coleville, decreased seasonally and remained below the normal range for the 9th time in the past 10 months. Monthly and daily mean flows have been lowest for their respective months at this station in 5 of the past 7 months, but during July the monthly and minimum daily mean discharges were about 50 percent greater than the July record-low minimums recorded in 1924. The monthend contents of major reservoirs in northern California were 36 percent of average and 55 percent of those of a year ago. The drought in California continues and conservation of water is being urged in all parts of the State. Water-use restrictions are reported to vary in accordance with the source and demand for water.

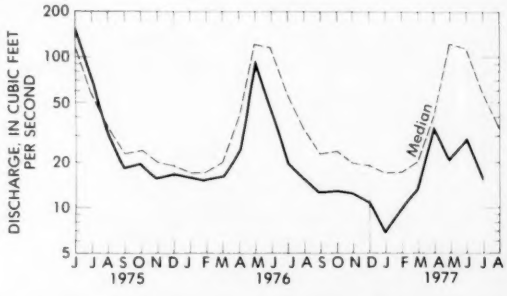
In Colorado, streamflow decreased seasonally, remained below the normal range, and was lowest of

record for July in the central part of the State. For example, east of the Continental Divide, the monthly mean discharge of 210 cfs in Arkansas River at Canon City (drainage area, 3,117 square miles) was only 16 percent of median, was below the normal range for the 8th consecutive month, and was lowest for the month in 89 years of record. The previous July minimum monthly discharge was 229 cfs, recorded in 1902. Also in central Colorado, west of the Divide, the monthly mean flow of 365 cfs in Roaring Fork River at Glenwood Springs (drainage area, 1,451 square miles) was 18 percent of median, below the normal range for the 6th consecutive month, and was lowest for July in 71 years of record. Also west of the Divide, mean flows decreased sharply in Animas River at Durango and Yampa River at Steamboat Springs, were less than one-third median, and remained below the normal range for the 9th consecutive month.

In southwestern Idaho, the monthly mean flow of 5,391 cfs in Snake River near Weiser (drainage area, 69,200 square miles) was lowest for July in 67 years of record and was below the normal range for the 6th consecutive month. In the southeastern part of the State, mean flow in Snake River near Heise also was below the normal range for the 6th consecutive month. In north-central Idaho, monthly mean flows in Salmon River at Whitebird and Clearwater River at Spalding decreased seasonally and remained below the normal range for the 7th and 8th months, respectively. Elsewhere in the State, mean flows in Boise, Coeur d'Alene, Kootenai, and Weiser Rivers were in the below-normal range and varied from the 3d to the 5th lowest July mean discharge in their respective periods of record. Monthend storage in southern Idaho reservoirs was far below normal.

In Montana, monthly mean discharge decreased seasonally and remained below the normal range at all index stations. The monthly mean discharge of 4,630 cfs in Yellowstone River at Billings (drainage area, 11,795 square miles) was lowest for the month in 46 years of record, and was below the normal range for the 3d consecutive month. Upstream, at Corwin Springs (drainage area, 2,623 square miles) the monthly mean flow of 2,831 cfs also was in the below-normal range for the 3d consecutive month, and was lowest for July since 1934. In northwestern Montana, the monthly mean discharge of 159 cfs in Marias River near Shelby (drainage area, 3,242 square miles) was only 17 percent of median, in the below-normal range for the 5th consecutive month, and only 8 percent greater than the July minimum monthly mean discharge in 69 years of record. West of the Continental Divide, mean flow in Clark Fork at St. Regis remained below the normal range for the 7th consecutive month and was lowest for July since 1940. Also west of the Divide, monthly mean flow in Middle Fork Flathead River near West Glacier continued to decrease seasonally, was below the normal range for the 9th time in the past 10 months, and was lowest for July since 1944.

In Utah, mean flows also decreased seasonally and remained below the normal range at all index stations in the State. In the southwestern part of Utah, the monthly mean discharge of 14.9 cfs, and the daily mean of 12 cfs from the 10th through the 16th, in Beaver River near Beaver (drainage area, 90.7 square miles) were lowest for the month since records began in March 1914. (See graph.) In extreme eastern Utah and the adjacent area of



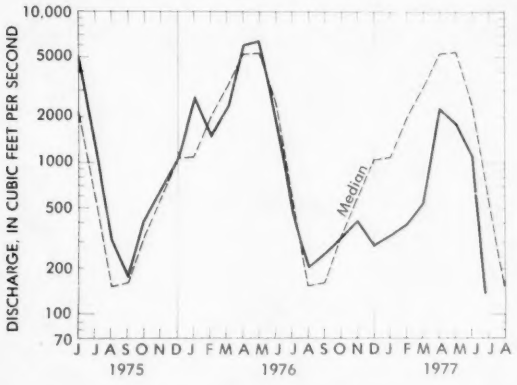
Monthly mean discharge of Beaver River near Beaver, Utah (Drainage area, 90.7 sq mi; 235 sq km)

western Colorado, the monthly mean discharge of 883 cfs, in Colorado River near Cisco, Utah (adjusted for reservoir storage) was lowest for July since records began in 1911. In extreme southeastern Utah, and the adjacent areas of Arizona, New Mexico, and Colorado, the monthly mean flow in San Juan River near Bluff, adjusted for reservoir storage, was 0 cfs. Other periods of no flow occurred July 3–13, 1934 and August 24–27, 29, 1939, in 63 years of record. In northern Utah, mean flow in Weber River near Oakley decreased seasonally, was about one-third of median, and remained below the normal range for the 11th consecutive month. Also in the northern part of the State, monthly mean flows in Big Cottonwood Creek near Salt Lake City and Whiterocks River near Whiterocks also decreased seasonally and remained below the normal range. Flash flooding occurred July 19 in the industrial park in West Jordan, and in areas along the east foothills of the Oquirrh Mountains, in Salt Lake Valley.

In northeastern Nevada, monthly mean discharge in Humboldt River at Palisade decreased seasonally, was only 20 percent of the July median flow, and remained below the normal range for the 6th consecutive month.

In north-coastal Oregon, where monthly mean flow of Wilson River near Tillamook was above the normal range

in June, flow decreased sharply in July and was below the normal range. In southwestern Oregon, monthly mean discharge in Umpqua River near Elkton continued to decrease seasonally and was below the normal range for the 8th time in the past 9 months. In eastern Oregon, mean flow in John Day River at Service Creek also continued to decrease seasonally, was only one-fourth of median, and remained below the normal range for the 9th consecutive month. (See graph.) Similarly, in the



Monthly mean discharge of John Day River near Service Creek, Oreg. (Drainage area, 5,090 sq mi; 13,200 sq km)

western part of the State, mean flow in Willamette River at Salem decreased seasonally and was in the below-normal range, where it was for 7 consecutive months, October 1976 through April 1977. July water-level elevations in Willamette River in the Portland harbor, and in Columbia River at Vancouver, Washington, were lowest in record beginning in 1879 on Willamette River, and in 1902 on Columbia River.

In Alberta and British Columbia, monthly mean flows decreased seasonally and were less than July medians at all index stations. In west-central Alberta, mean flow in Athabasca River at Hinton and Bow River at Banff remained in the below-normal range. In southern British Columbia, flow in Fraser River at Hope decreased but was in the normal range.

In northern Wyoming, mean flow in Tongue River near Dayton decreased sharply to 57 percent of median and was below the normal range. In the south-central part of the State, monthly mean flow in North Platte River above Seminoe Reservoir, near Sinclair, decreased seasonally, was only 29 percent of median for July, and remained in the below-normal range for the 7th consecutive month.

In New Mexico, monthly mean flows increased at all index stations and were in the normal range except in the north-central part of the State, where flow in Rio Grande below Taos Junction Bridge near Taos (drainage area, 9,730 square miles) remained below the normal range for the 4th consecutive month. The mean discharge of 200 cfs was only 8 percent greater than the minimum July monthly mean, recorded in 1959, in record that began in July 1925. Monthend storage in the major irrigation reservoirs generally decreased during the month and remained well below the 1961–75 average.

In Arizona, monthly mean discharge also increased at all index stations and was above the normal range in some parts of the State. In southeastern Arizona, mean flow in Gila River at head of Safford Valley increased seasonally as a result of runoff from rains near month-end, and was in the above-normal range. Similarly, in the northeastern part of the State, increased runoff in Little Colorado River near Cameron, on the 24th, resulted in monthly mean discharge that was about 4 times median and above the normal range. In the Virgin River basin, in extreme northwestern Arizona and the adjacent area of Utah, monthly mean flow, as measured at Littlefield, Arizona, also increased into the above-normal range as a result of runoff from rains during the latter part of the month.

Contents of the Colorado River Storage Project decreased 644,820 acre-feet during the month.

Ground-water levels in eastern and western Washington declined and continued below average for the 9th consecutive month; levels in several wells dropped to new July lows. In Idaho, the level in the well penetrating the sand and gravel aquifer in the Boise Valley continued its seasonal rise and was above average. Levels in the key wells representative of the Snake River Plain declined and were below average near Atomic City and Eden, and were nearly at the record lows for July in the heavily pumped Rupert-Minidoka area and near Gooding. The level in the well in the alluvial aquifer of the Rathdrum Prairie, northern Idaho, declined and continued below average. In western Montana, the levels in the terrace gravel wells at Missoula and Hamilton rose less than a foot but continued below average. In southern California, levels in selected observation wells declined except in the Santa Maria Valley well; all continued below average, and a new July low was reached in the water-table well at Baldwin Park. In Nevada, the artesian levels in the wells in Las Vegas and Truckee Meadows declined and reached new lows for July. The level in the Paradise Valley water-table well declined and continued below average. Although the artesian level in the well in Steptoe Valley declined nearly a foot, the level was nearly 2 feet above average and at a new record high for July. Levels in Utah generally declined and generally were below average; a new low for July was reached in the artesian well in the

(Continued on page 17.)

DISSOLVED SOLIDS AND WATER TEMPERATURES FOR JULY AT DOWNSTREAM SITES ON SIX LARGE RIVERS

Station number	Station name	July data of following calendar years	Stream discharge during month, Mean (cfs)	Dissolved-solids concentration during month[a] Minimum (mg/L)	Dissolved-solids concentration during month[a] Maximum (mg/L)	Dissolved-solids discharge during month[a] Mean (tons per day)	Dissolved-solids discharge during month[a] Minimum (tons per day)	Dissolved-solids discharge during month[a] Maximum (tons per day)	Water temperature during month[b] Mean, in °C	Water temperature during month[b] Minimum, in °C	Water temperature during month[b] Maximum, in °C
	NORTHEAST										
01463500	Delaware River at Trenton, N.J.	1977	3,980	96	112	1,160	724	1,480	27.0	21.0	32.5
	(Morrisville, Pa.)	1945–75 (Extreme yr)	7,484 [c5,066]	57 (1947)	143 (1965)	.....	465 (1965)	16,700 (1969)	....	18.5	33.5
04264331	St. Lawrence River at Cornwall, Ontario, near Massena, N.Y. (streamflow station formerly at Ogdensburg, N.Y.)	1977	249,000	166	167	112,000	109,000	114,000	19.5	18.0	21.5
		1976	350,000	166	167	157,000	153,000	158,000	19.5	18.5	20.0
		1966–76	286,300 [c256,600]	.....	.....	.....	.....	.....	20.0	15.5	24.0
	SOUTHEAST										
07289000	Mississippi River at Vicksburg, Miss	1977	368,900	211	295	235,000	163,000	325,000	30.0	28.0	31.5
		1976	545,100 [c456,600]	232	270	309,000	224,000	383,000	28.0	23.5	30.5
	WESTERN GREAT LAKES REGION										
03612500	Ohio River at lock and dam 53, near Grand Chain, Ill. (25 miles west of Paducah, Ky.; streamflow station at Metropolis, Ill.)	1977	143,000	204	254	.....	57,600	130,000	....	25.0	31.0
		1955–76 (Extreme yr)	156,600 [c130,200]	124 (1965, 1967)	276 (1968)	.....	25,000 (1966)	237,000 (1958)	....	16.5	31.0
	MIDCONTINENT										
06934500	Missouri River at Hermann, Mo. (60 miles west of St. Louis, Mo.)	1977	76,700	239	421	62,300	44,700	110,000	28.0	24.5	30.0
		1976	59,400 [c79,360]	298	386	56,400	50,000	75,900	27.5	25.0	30.0
	WEST										
14128910	Columbia River at Warrendale, Oreg. (30 miles east of Portland, Oreg.; streamflow station at The Dalles, Oreg.)	1977	88,600	85	93	21,100	12,500	28,200	19.5	19.0	20.0
		1976	238,500	60	71	43,200	33,900	54,700	18.0	16.0	20.0
		1968–76	235,800 [c275,900]								

[a]Dissolved-solids concentrations when not analyzed directly, are calculated on basis of measurements of specific conductance.
[b]To convert °C to °F: [(1.8 X °C) + 32] = °F.
[c]Median of monthly values for 30-year reference period, water years 1941–70, for comparison with data for current month.

USABLE CONTENTS OF SELECTED RESERVOIRS NEAR END OF JULY 1977

[Contents are expressed in percent of reservoir capacity. The usable storage capacity of each reservoir is shown in the column headed "Normal maximum."]

Reservoir Principal uses: F–Flood control I–Irrigation M–Municipal P–Power R–Recreation W–Industrial	End of June 1977	End of July 1977	End of July 1976	Average for end of July	Normal maximum
	Percent of normal maximum				
NORTHEAST REGION					
NOVA SCOTIA					
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs (P)	85	79	74	59	226,300 (a)
QUEBEC					
Allard (P)	93	89	88	75	280,600 ac-ft
Gouin (P)	80	96	84	66	6,954,000 ac-ft
MAINE					
Seven reservoir systems (MP)	100	85	92	79	178,500 mcf
NEW HAMPSHIRE					
First Connecticut Lake (P)	93	87	86	88	3,330 mcf
Lake Francis (FPR)	90	81	79	87	4,326 mcf
Lake Winnipesaukee (PR)	105	93	95	87	7,200 mcf
VERMONT					
Harriman (P)	82	78	78	78	5,060 mcf
Somerset (P)	82	80	88	83	2,500 mcf
MASSACHUSETTS					
Cobble Mountain and Borden Brook (MP)	84	80	83	83	3,394 mcf
NEW YORK					
Great Sacandaga Lake (FPR)	87	83	89	83	34,270 mcf
Indian Lake (FMP)	97	90	100	90	4,500 mcf
New York City reservoir system (MW)	94	86	93	.....	547,500 mg
NEW JERSEY					
Wanaque (M)	87	76	95	82	27,730 mg
PENNSYLVANIA					
Allegheny (FPR)	48	47	48	44	51,400 mcf
Pymatuning (FMR)	95	100	91	93	8,191 mcf
Raystown Lake (FR)	66	68	67	53	33,190 mcf
Lake Wallenpaupack (PR)	84	71	75	73	6,875 mcf
MARYLAND					
Baltimore municipal system (M)	90	86	98	91	85,340 mg
SOUTHEAST REGION					
NORTH CAROLINA					
Bridgewater (Lake James) (P)	93	86	94	89	12,580 mcf
Narrows (Badin Lake) (P)	92	96	97	97	5,617 mcf
High Rock Lake (P)	86	65	82	76	10,230 mcf
SOUTH CAROLINA					
Lake Murray (P)	89	82	92	75	70,300 mcf
Lakes Marion and Moultrie (P)	79	71	85	70	81,100 mcf
SOUTH CAROLINA--GEORGIA					
Clark Hill (FP)	71	63	80	70	75,360 mcf
GEORGIA					
Burton (PR)	95	90	94	91	104,000 ac-ft
Sinclair (MPR)	86	82	84	91	214,000 ac-ft
Lake Sidney Lanier (FMPR)	64	59	64	62	1,686,000 ac-ft
ALABAMA					
Lake Martin (P)	92	90	96	90	1,373,000 ac-ft
TENNESSEE VALLEY					
Clinch Projects: Norris and Melton Hill Lakes (FPR)	58	48	56	56	1,156,000 cfsd
Douglas Lake (FPR)	63	45	73	60	703,100 cfsd
Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parksville Lakes (FPR)	88	77	90	76	510,300 cfsd
Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR)	61	54	63	62	1,452,000 cfsd
Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR)	81	72	90	78	745,200 cfsd
WESTERN GREAT LAKES REGION					
WISCONSIN					
Chippewa and Flambeau (PR)	81	77	79	84	15,900 mcf
Wisconsin River (21 reservoirs) (PR)	50	47	51	74	17,400 mcf
MINNESOTA					
Mississippi River headwater system (FMR)	26	24	25	38	1,640,000 ac-ft
MIDCONTINENT REGION					
NORTH DAKOTA					
Lake Sakakawea (Garrison) (FIPR)	82	80	98	.....	22,640,000 ac-ft
SOUTH DAKOTA					
Angostura (I)	66	59	72	85	127,600 ac-ft
Bell Fourche (I)	47	23	50	55	185,200 ac-ft
Lake Francis Case (FIP)	76	72	78	82	4,834,000 ac-ft
Lake Oahe (FIP)	82	79	86	.....	22,530,000 ac-ft

Reservoir Principal uses: F–Flood control I–Irrigation M–Municipal P–Power R–Recreation W–Industrial	End of June 1977	End of July 1977	End of July 1976	Average for end of July	Normal maximum
	Percent of normal maximum				
MIDCONTINENT REGION--Continued					
SOUTH DAKOTA--Continued					
Lake Sharpe (FIP)	103	101	103	99	1,725,000 ac-ft
Lewis and Clarke Lake (FIP)	89	95	92	95	477,000 ac-ft
NEBRASKA					
Lake McConaughy (IP)	78	67	69	74	1,948,000 ac-ft
OKLAHOMA					
Eufaula (FPR)	98	94	88	85	2,378,000 ac-ft
Keystone (FPR)	101	102	102	94	661,000 ac-ft
Tenkiller Ferry (FPR)	100	95	101	95	628,200 ac-ft
Lake Altus (FIMR)	100	81	82	61	134,500 ac-ft
Lake O'The Cherokees (FPR)	109	94	94	91	1,492,000 ac-ft
OKLAHOMA--TEXAS					
Lake Texoma (FMPRW)	101	98	99	97	2,722,000 ac-ft
TEXAS					
Bridgeport (IMW)	98	91	90	49	386,400 ac-ft
Canyon (FMR)	99	92	100	71	385,600 ac-ft
International Amistad (FIMPW)	100	100	100	63	3,497,000 ac-ft
International Falcon (FIMPW)	100	96	100	65	2,667,000 ac-ft
Livingston (IMW)	100	100	100	76	1,788,000 ac-ft
Possum Kingdom (IMPRW)	94	94	92	105	569,400 ac-ft
Red Bluff (PI)	15	13	25	24	307,000 ac-ft
Toledo Bend (P)	94	96	100	86	4,472,000 ac-ft
Twin Buttes (FIM)	96	89	92	14	177,800 ac-ft
Lake Kemp (IMW)	93	84	71	92	268,000 ac-ft
Lake Meredith (FMW)	37	36	38	40	821,300 ac-ft
Lake Travis (FIMPRW)	98	92	100	77	1,144,000 ac-ft
THE WEST					
WASHINGTON					
Ross (PR)	58	66	99	96	1,052,000 ac-ft
Franklin D. Roosevelt Lake (IP)	80	94	97	94	5,232,000 ac-ft
Lake Chelan (PR)	85	87	97	99	676,100 ac-ft
Lake Cushman	73	77	103	99	359,500 ac-ft
Lake Merwin (P)	108	106	106	105	246,000 ac-ft
IDAHO					
Boise River (4 reservoirs) (FIP)	47	32	75	78	1,235,000 ac-ft
Coeur d'Alene Lake (P)	102	98	99	80	238,500 ac-ft
Pend Oreille Lake (FP)	90	100	100	94	1,561,000 ac-ft
IDAHO--WYOMING					
Upper Snake River (8 reservoirs) (MP)	53	31	68	72	4,401,000 ac-ft
WYOMING					
Boysen (FIP)	70	64	86	90	802,000 ac-ft
Buffalo Bill (IP)	74	61	103	102	421,300 ac-ft
Keyhole (F)	71	68	75	46	199,900 ac-ft
Pathfinder, Seminoe, Alcova, Kortes, Glendo, and Guernsey Reservoirs (I)	62	52	71	56	3,056,000 ac-ft
COLORADO					
John Martin (FIR)	0	0	0	20	364,400 ac-ft
Taylor Park (IR)	64	57	81	92	106,200 ac-ft
Colorado–Big Thompson project (I)	48	34	68	74	722,600 ac-ft
COLORADO RIVER STORAGE PROJECT					
Lake Powell; Flaming Gorge, Navajo, and Blue Mesa Reservoirs (IFPR)	70	68	83	.....	31,280,000 ac-ft
UTAH--IDAHO					
Bear Lake (IPR)	67	60	89	66	1,421,000 ac-ft
CALIFORNIA					
Folsom (FIP)	26	24	53	80	1,000,000 ac-ft
Hetch Hetchy (MP)	41	41	50	78	360,400 ac-ft
Isabella (FIR)	15	10	17	39	551,800 ac-ft
Pine Flat (FI)	35	15	27	53	1,014,000 ac-ft
Clair Engle Lake (Lewiston) (P)	32	23	76	88	2,438,000 ac-ft
Lake Almanor (P)	65	64	59	60	1,036,000 ac-ft
Lake Berryessa (FIMW)	55	52	70	83	1,600,000 ac-ft
Millerton Lake (FI)	46	42	49	64	503,200 ac-ft
Shasta Lake (FIPR)	22	16	39	80	4,377,000 ac-ft
CALIFORNIA--NEVADA					
Lake Tahoe (IPR)	19	19	54	71	744,600 ac-ft
NEVADA					
Rye Patch (I)	52	42	76	92	157,200 ac-ft
ARIZONA--NEVADA					
Lake Mead and Lake Mohave (FIMP)	76	75	78	72	27,970,000 ac-ft
ARIZONA					
San Carlos (IP)	0	0	2	12	1,073,000 ac-ft
Salt and Verde River system (IMPR)	36	30	56	39	2,073,000 ac-ft
NEW MEXICO					
Conchas (FIR)	23	23	27	78	352,600 ac-ft
Elephant Butte and Caballo (FIPR)	10	8	18	26	2,539,000 ac-ft

[a]Thousands of kilowatt-hours (the potential electric power that could be generated by the volume of water in storage).

FLOW OF LARGE RIVERS DURING JULY 1977

Station number*	Stream and place of determination	Drainage area (square miles)	Mean annual discharge through September 1970 (cfs)	July 1977					
				Monthly discharge (cfs)	Percent of median monthly discharge, 1941–70	Change in discharge from previous month (percent)	Discharge near end of month		
							(cfs)	(mgd)	Date
1–0140	St. John River below Fish River at Fort Kent, Maine.	5,690	9,397	4,807	103	-62	2,800	1,810	31
1–3185	Hudson River at Hadley, N.Y	1,664	2,791	658	58	-47	580	370	31
1–3575	Mohawk River at Cohoes, N.Y.....	3,456	5,450	1,640	89	-11	.....	.....	....
1–4635	Delaware River at Trenton, N.J	6,780	11,360	4,006	79	-16	3,280	2,120	26
1–5705	Susquehanna River at Harrisburg, Pa.	24,100	33,670	16,510	142	+67	12,800	8,300	31
1–6465	Potomac River near Washington, D.C.	11,560	[1]10,640	2,470	56	-16	2,200	1,420	31
2–1055	Cape Fear River at William O. Huske Lock near Tarheel, N.C.	4,810	4,847	664	30	-47	330	210	31
2–1310	Pee Dee River at Peedee, S.C	8,830	9,098	2,970	51	-19	2,170	1,400	27
2–2260	Altamaha River at Doctortown, Ga.	13,600	13,380	3,625	51	-26	3,580	2,310	28
2–3205	Suwannee River at Branford, Fla	7,740	6,775	2,840	57	-16	2,570	1,660	31
2–3580	Apalachicola River at Chattahoochee, Fla.	17,200	21,690	10,300	66	-19	9,810	6,340	29
2–4670	Tombigbee River at Demopolis lock and dam near Coatopa, Ala.	15,400	21,700	4,398	75	+9	9,700	6,300	29
2–4895	Pearl River near Bogalusa, La	6,630	8,533	2,411	84	+8	1,900	1,230	31
3–0495	Allegheny River at Natrona, Pa	11,410	[1]18,700	19,590	326	+364	33,800	21,800	25
3–0850	Monongahela River at Braddock, Pa.	7,337	[1]11,950	4,342	105	+23	2,450	1,580	25
3–1930	Kanawha River at Kanawha Falls, W.Va.	8,367	12,370	4,066	84	-23	3,600	2,330	29
3–2345	Scioto River at Higby, Ohio	5,131	4,337	1,199	76	+17	910	590	26
3–2945	Ohio River at Louisville, Ky[2]	91,170	110,600	54,540	126	+89	68,000	43,900	28
3–3775	Wabash River at Mount Carmel, Ill.	28,600	26,310	9,741	66	+46	5,620	3,630	25
3–4690	French Broad River below Douglas Dam, Tenn.	4,543	[1]6,528	3,473	85	-45	.....	.....	....
4–0845	Fox River at Rapide Croche Dam, near Wrightstown, Wis.[2]	6,150	4,142	1,700	58	-16	.....	.....	....
02MC002 (4–2643.31)	St. Lawrence River at Cornwall, Ontario–near Massena, N.Y.[3]	299,000	239,100	249,500	97	-5	252,000	163,000	31
050115	St. Maurice River at Grand Mere, Quebec.	16,300	24,900	16,000	74	-27	17,100	11,100	28
5–0825	Red River of the North at Grand Forks, N. Dak.	30,100	2,439	576	20	+19	370	240	31
5–3300	Minnesota River near Jordan, Minn ..	16,200	3,306	928	24	-60	1,080	700	25
5–3310	Mississippi River at St. Paul, Minn ...	36,800	[1]10,230	3,924	33	-28	3,340	2,160	25
5–3655	Chippewa River at Chippewa Falls, Wis.	5,600	5,062	3,032	81	+28	.....	.....	....
5–4070	Wisconsin River at Muscoda, Wis	10,300	8,457	3,900	58	-25	.....	.....	....
5–4465	Rock River near Joslin, Ill	9,520	5,288	2,710	78	+41	3,800	2,460	31
5–4745	Mississippi River at Keokuk, Iowa ...	119,000	61,210	31,900	48	+16	21,000	13,600	31
5–4855	Des Moines River below Raccoon River at Des Moines, Iowa.	9,879	3,796	110	3	-61	70	45	31
6–2145	Yellowstone River at Billings, Mont.	11,795	6,754	4,630	31	-70	3,200	2,100	31
6–9345	Missouri River at Hermann, Mo	528,200	78,480	76,910	97	-7	46,200	29,900	27
7–2890	Mississippi River at Vicksburg, Miss.[4]	1,144,500	552,700	370,100	81	+42	285,000	184,000	31
7–3310	Washita River near Durwood, Okla ..	7,202	1,379	422	63	-82	210	140	31
8–2765	Rio Grande below Taos Junction Bridge, near Taos, N. Mex.	9,730	732	200	60	+6	200	130	31
9–3150	Green River at Green River, Utah ...	40,600	6,369	1,128	18	-79	3,000	1,900	27
11–4255	Sacramento River at Verona, Calif ...	21,257	18,370	7,335	93	+32	7,850	5,070	28
13–2690	Snake River at Weiser, Idaho	69,200	17,670	5,391	50	-20	6,040	3,900	26
13–3170	Salmon River at White Bird, Idaho ..	13,550	11,060	5,218	38	-39	5,200	3,350	26
13–3425	Clearwater River at Spalding, Idaho ..	9,570	15,320	7,690	80	-39	7,690	4,960	26
14–1057	Columbia River at The Dalles, Oreg.[5]	237,000	194,000	115,100	43	-54	.....	.....	....
14–1910	Willamette River at Salem, Oreg	7,280	23,370	3,799	53	-65	6,240	4,030	27–31
15–5155	Tanana River at Nenana, Alaska	25,600	24,040	50,890	88	-6	41,000	26,000	30
8MF005	Fraser River at Hope, British Columbia.	83,800	95,300	170,000	93	-15	152,000	98,200	28

[1]Adjusted.
[2]Records furnished by Corps of Engineers.
[3]Records furnished by Buffalo District, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y. when adjusted for storage in Lake St. Lawrence.
[4]Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.
[5]Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.
*The U.S. station numbers as listed in this table are in a shortened form previously in use, and used here for simplicity of tabular and map presentation. The full, correct number contains 8 digits and no punctuation marks. For example, the correct form for station number 1–3185 is 01318500.

(Continued from page 13.)

Logan area. The level in the well in the Holladay area, however, rose nearly a foot but continued below average; on the other hand, the level in the well in the Blanding area declined 0.6 foot but continued above average. Mixed trends occurred in Arizona, but levels were generally below average. Three alltime lows were measured, including those in the Tucson and Elfrida water-table observation wells. In New Mexico, levels generally declined and continued below average. The artesian level in the Berrendo-Smith well in the Roswell artesian basin declined a little more than a foot, was nearly 4 feet below average but nearly 2 feet above the level of a year ago. The level in the water-table well in the bolson deposits in the Mimbres Valley declined less than ¼ foot, was nearly 10 feet below average but more than 2 feet above the July 1976 level. A new July low was reached in 39 years of record in the Dayton well in the shallow alluvial aquifer in the southern part of the Roswell artesian basin.

ALASKA

Streamflow generally decreased except in the eastern part of the State, where flows decreased contraseasonally, and in the south-coastal area, where flows increased seasonally. In extreme southeastern Alaska, where last winter's snowpack was below normal and precipitation during the summer has been below average, the monthly mean flow of 144 cfs in Gold Creek near Juneau (drainage area, 9.76 square miles) was lowest for July in record that began in 1946. Conversely, in the south-central coastal basin of Kenai River, mean flow of 10,350 cfs at the index station at Cooper Landing (drainage area, 634 square miles) was highest for the month in 28 years of record, and was above the normal range for the 8th time in the past 10 months. If runoff at that station is normal during August and September, total annual runoff for 1977 water year will be maximum for the period of record. In south-central Alaska, flow in Little Susitna River near Palmer decreased sharply, as a result of below-normal precipitation and a diminished snowpack. In the east-central part of the State, monthly mean flow in Chena River at Fairbanks decreased seasonally and remained in the normal range, but in the adjacent basin of Tanana River, where July flow normally is greater than flow in June, monthly mean discharge decreased contraseasonally, at the index station at Nenana, and was in the below-normal range.

Ground-water levels in the Anchorage area rose near the mountain front and declined in the lowlands.

HAWAII

Streamflow generally increased, and was in the normal range. On the western island of Oahu, where monthly mean flow in Kalihi Stream near Honolulu was above the normal range during April, May, and June, flow decreased sharply in July, was one-half of median for the month, and was within the normal range.

WATER RESOURCES REVIEW

July 1977

Based on reports from the Canadian and U.S. field offices; completed August 19, 1977

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EXPLANATION OF DATA

Cover map shows generalized pattern of streamflow for July based on 20 index stream-gaging stations in Canada and 130 index stations in the United States. Alaska and Hawaii inset maps show streamflow only at the index gaging stations which are located near the points shown by the arrows.

Streamflow for July 1977 is compared with flow for July in the 30-year reference period 1941–70. Streamflow is considered to be *below the normal range* if it is within the range of the low flows that have occurred 25 percent of the time (below the lower quartile) during the reference period. Flow for July is considered to be *above the normal range* if it is within the range of the high flows that have occurred 25 percent of the time (above the upper quartile).

Flow higher than the lower quartile but lower than the upper quartile is described as being *within the normal range.* In the Water Resources Review the median is obtained by ranking the 30 flows of the reference period in their order of magnitude; the highest flow is number 1, the lowest flow is number 30, and the average of the 15th and 16th highest flows is the median.

The normal is an average (but not an arithmetic average) or middle value; half of the time you would expect the July flows to be below the median and half of the time to be above the median. Shorter reference periods are used for the Alaska index stations because of the limited records available.

Statements about *ground-water levels* refer to conditions near the end of July. Water level in each key observation well is compared with average level for the end of July determined from the entire past record for that well or from a 20-year reference period, 1951–70. *Changes in ground-water levels,* unless described otherwise, are from the end of June to the end of July.

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MOVEMENT OF MOISTURE IN THE UNSATURATED ZONE IN A LOESS-MANTLED AREA, SOUTHWESTERN KANSAS

The abstract and accompaniny map and graph are from the report, *Movement of Moisture in the Unsaturated Zone in a Loess-Mantled Area, Southwestern Kansas,* by Robert C. Prill: U.S. Geological Survey Professional Paper 1021, 21 pages, 1977. This report may be purchased for $1.70 from Branch of Distribution, U.S. Geological Survey, 1200 S. Eads St., Arlington, VA 22202 (check or money order payable to U.S. Geological Survey); or from Superintendent of Documents, Government Printing Office, Washington, D.C. 20402 (payable to Superintendent of Documents).

ABSTRACT

A study of moisture movement associated with four ponding tests in a loess-mantled area near Garden City, Kans., (fig. 1) provides significant information on the potential of using the area for artificial recharge by water spreading.

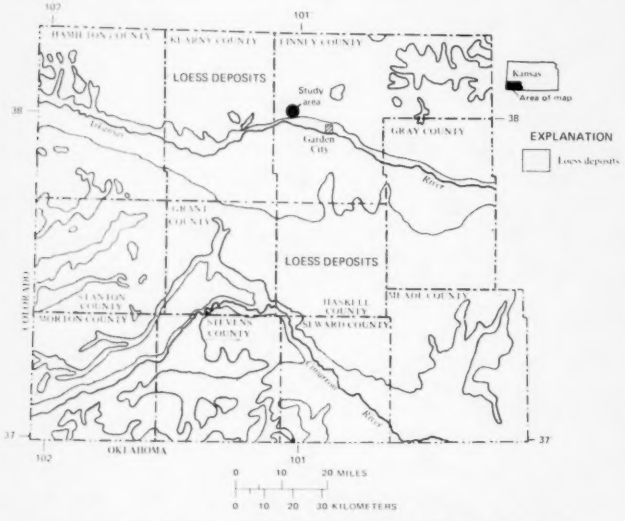

Figure 1.—Map of southwestern Kansas showing location of study area and distribution of loess deposits.

Infiltration during the four ponding tests stabilized at rates ranging from 0.7 to 2.2 feet (0.2 to 0.7 meter) per day. The large differences in infiltration rates reflect changes in the hydraulic conductivity of the soil horizons developed in loess materials. The underlying loess has an appreciably greater hydraulic conductivity than the soil. Removing the soil zone should increase infiltration rates, provided that the underlying loess is not severely compacted during excavation or during subsequent recharge operations.

When the wetting front of infiltrated water is in the loess, the moisture-buildup pattern shows the characteristic wetting and transmission zones observed for infiltration in homogeneous materials. When the wetting front penetrates the underlying alluvium, the wetting front becomes indistinct.

The loess has the capacity to take large quantities of water into temporary storage. If adequate time is allowed between water applications for the loess to drain, the amount may be as much as 1 cubic foot (0.03 cubic meter) of water for each 6 cubic feet (0.17 cubic meter) of the material.

At the ponding site, several fine-grained strata are in the unsaturated alluvium underlying the loess. Because these strata have relatively high hydraulic conductivities, they did not act as effective perching beds during the ponding tests. Strata of this type probably would not cause sufficient mounding to impede infiltration significantly or cause water-logged conditions during water spreading.

The ground-water mound (fig. 2) that developed after application of 21 feet (6 meters) of water has a maximum thickness of 2 feet (0.6 meter) at the edge of the pond. The boundary of the mound moved laterally a distance of 50 feet (15 meters) from the edge of the pond in 2 days. The mound, which dissipated very slowly because of additional drainage from the unsaturated zone, was discernible 3 months after ponding. Although the mound on the saturated zone spread rapidly as a result of pressure transmission, the recharged water actually spread slowly by lateral displacement.

Because accumulated salts are leached from the unsaturated zone, the specific conductance of water arriving at the water table is higher than that of the applied water. The amount of increase is dependent on the extent of leaching from previous applications of water and on dilution by infiltrated water.

A general appraisal of the ponding-test data indicates that the study area has an excellent potential for artificial recharge by water spreading. Infiltration rates in the loess-mantled area would be favorable for water spreading, and fine-grained strata in the unsaturated zone would not significantly impede downward percolation. Water that is put into underground storage by utilizing the dewatered part of the reservoir would help to sustain the productivity of the aquifer system.

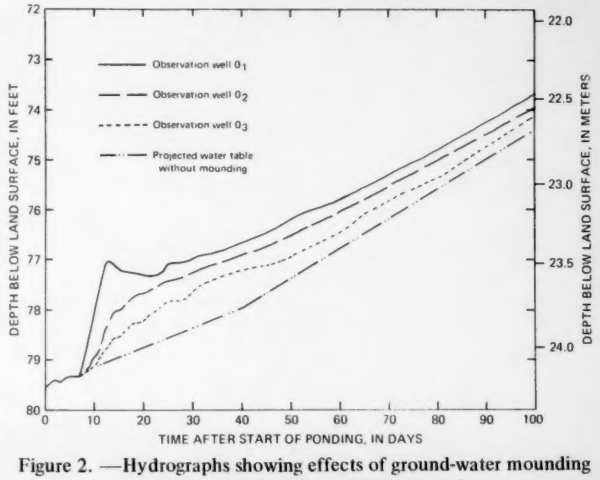

Figure 2. —Hydrographs showing effects of ground-water mounding at southeast radial of pond during test 4.